

III-14.01 Introduction

The safety review is used to determine what roadside obstructions are cost-effective to eliminate, move outside the roadway clear zone, or make them crashworthy. Obstructions to the errant vehicle leaving the roadway are non-yielding, non-breakaway supports, lighting and utility poles, signal standards, culvert openings over 30 inches in diameter, box culvert openings of all sizes, bridge rail ends, bridge piers, trees over 4 inches in diameter, and large rocks. Steep slopes steeper than 1:4 are non-recoverable slopes and vehicles are likely to overturn. Water over 2 feet deep is considered an obstruction.

Clear Zone is defined as the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired width is dependent upon the traffic volume, travel speeds, and on the roadside geometry. See Tables 1 and 2 III-14 B.

III-14.02 Field Survey

The field surveys are made to determine the location and size of all obstructions along the roadway.

Bridges should have the type of bridge railing determined and the cross section of the bridge measured. The location of the face of the bridge railing should be measured from the roadway centerline. The bridge railing should be of a type that is crashworthy. Some of the bridge railings that have been tested and accepted are shown in Appendix III-14 A. The bridge rails that the department uses and are accepted are shown in Figure 1.

If bridge piers are along the roadway, the roadway side of the pier should be measured from the roadway centerline. The size and shape of the individual piers should be measured and the distance between all piers. If the pier is one unit, the overall length and width should be measured.

Where trees are encountered, the location and size of all trees should be determined. The lateral distance to the trees from the roadway centerline should be determined. Trees of less than 4 inches diameter need not be located or sized.

Where rock outcroppings, rip-rapping, and retaining walls are encountered, the distance from the roadway centerline should be determined and the longitudinal limits should be measured. Embedded rocks that protrude more than 4 inches out of the surrounding ground surface should be located.

The culverts over 30 inches in diameter should be measured from the roadway centerline to the beginning of the culvert opening. All box culvert headwalls should be measured from the

roadway centerline and the headwall limits. The limits of the wingwall ends farthest from the roadway should be measured from the roadway centerline and their longitudinal limits. All drop inlets that protrude above the surrounding area in a radius of 5 feet by more than 4 inches should be measured.

The driveways should have their foreslopes measured to determine the slope rate. The driveway culvert offset distance should be measured from the roadway centerline. The size of the culvert should be measured and its length. It should be determined if a culvert end section exists. If mainline culverts exist within 100 feet of the driveways, they should be measured.

The roadway cross sections should be measured to determine if the foreslope slope rates are 1:3 or steeper, and the cross sections surveyed at every 300 to 500 feet intervals. If culverts exist within the steep slope area, the culverts should be surveyed to determine location, offset, and size. Any hazard that falls on the foreslope, or within 15 feet of the toe of the foreslope, should also be located. See Figure 2, Appendix III-14 A.

Any areas that have water standing for long periods of time (1 year or more), and at least 2 feet deep, should be surveyed with distances to the water measured from the roadway centerline, and their longitudinal distances.

Curbs generally are not to be used on high speed roadways. Curbs of more than 3 inches in height should not be used where guardrail is required. The existing curbs should be measured both laterally and longitudinally, and any drainage structures installed within the curbed area.

Light standards, signal standards, and any equipment required for these installations should be surveyed. The survey should include break-away features and height of slip-base, anchor bolts, or any other rigid feature more than 4 inches above the surrounding terrain within a 5 feet radius around the base. See Figure 3, III-14 A. If not yielding or break-away, the feature should be outside the clear zone.

Sign supports should be surveyed and should include break-away base feature and slip-base height more than 4 inches above the surrounding terrain with a 5 feet radius around the bases. See Figure 3, III-14 A.

III-14.03 Design Requirements

All obstructions should be removed within the clear zone (See Figures 1 and 2 in Appendix III-14 A). If the obstruction cannot be removed, it should be provided with a break-away system. If the obstruction cannot be made break-away, and cannot be removed, then it should be shielded.

All break-away systems should be of a type that has been crash tested successfully in accordance with “Recommended Procedure for the Safety Performance Evaluation of Highway Features” (NCHRP) Report 350

III-14.03.1 Roadside Signs

Roadside signs can be divided into three main categories: overhead signs, large roadside signs, and small roadside signs. The hardware and corresponding safety treatment of sign supports varies with the sign category.

1. **Overhead signs.** Where possible, overhead signs should be installed on overpasses or other structures. Overhead signs generally require massive support systems which cannot be made break-away. All overhead sign structures located within the clear zone should be shielded with crashworthy barriers
2. **Large Roadside Signs.** Large roadside signs may be defined as those greater than 50 square feet in area. They typically have two or more support posts which are break-away. The basic concept of the break-away sign support is to provide a structure that will resist wind and ice loads, yet fail in a safe and predictable manner when struck by a vehicle. The loadings for which the support should be designed are shown in Figure 4, III-14 A. The desired impact performance is depicted in Figure 5, III-14 A.

The term “break-away support” refers to all types of sign, luminaire, and traffic signal supports that are designed to yield when hit by a vehicle. The release mechanism may be a slip plane, plastic hinges, fracture elements, or a combination of these.

The obstruction may be shielded by using attenuation devices or guardrail which has been crash tested successfully in accordance with “Recommended Procedure for the Safety Performance Evaluation of Highway Features” (NCHRP) Report 350

III-14.03.2 Embankments (Parallel Slopes)

Embankments, or fill slopes parallel to the flow of traffic, are defined as recoverable, non-recoverable, traversable, or critical (see Figure 2, Appendix III-14 A). Recoverable slopes are all embankment slopes 1:4 or flatter. If such slopes are relatively smooth and traversable, the suggested clear zone distance may be taken from Tables 1 and 2, Appendix III-14 A.

A non-recoverable embankment slope is defined as one which is traversable, but from which a motorist will be unable to stop or return to the roadway easily. Vehicles on such slopes are expected to reach the bottom. Embankments between 1:3 and 1:4 fall into this category.

A critical embankment slope is one on which a vehicle is likely to overturn. Slopes steeper than 1:3 fall into this category.

A non-recoverable slope should be free of all obstructions because encroaching vehicles will reach the toe of these slopes. A clear runout area at the base is desirable and should have no obstructions. The clear runout area should be 15-17 feet wide with a 1:8 slope or less. It is recommended that a 1:24 slope be used in a 12 foot width when constructing this runout area.

III-14.03.3 Embankments (Cross Slopes)

Common obstacles on the roadside are embankment slopes created by median crossovers, driveways, intersecting side roads, and ditch blocks. These are more critical to errant vehicles than foreslopes and backslopes.

Cross slopes of 1:6 or flatter are acceptable, but embankment cross slopes of 1:10 are desirable. In safety reviews, all cross slopes steeper than 1:6 should be flattened to 1:10 (see Figure 6, Appendix III-14 A).

Parallel drainage structures are those which parallel the main line flow of traffic. These features can present a significant safety obstructions because they can be struck head-on by errant vehicles. Safety treatment options are similar to those for cross drainage structures:

- Eliminate the structure
- Use a traversable design
- Move the structure laterally to a less vulnerable location
- Shield the structure

Eliminating the structure may be difficult, but on field entrances and very low volume driveways an overflow section may be constructed.

Traversable designs are to provide grates constructed of pipes set on 24 inch centers to reduce wheel snagging. Generally, pipes of 24 inch diameter or less may not require a grate. However, when a multiple pipe installation is encountered, grating smaller pipe may be appropriate.

Relocating the structure is the most desirable. This allows the opportunity to flatten the cross slope within the clear zone distance of the roadway under design. If the new culvert location is placed well outside of the clear zone of the roadway under design, and the approach roadway clear zone, then this safety treatment should be considered.

In cases where the embankment cannot be made traversable, the structure is too large to be safety treated effectively and it cannot be relocated, it may be necessary to shield the obstacle with a traffic barrier.

III-14.04 Estimated Costs

The cost of making the improvements to enhance safety of the roadside should be used to determine if the improvements are cost effective.

The initial cost to make the improvements should be estimated to the nearest 100 dollars.

The maintenance costs to maintain the improvements should be on a yearly basis.

The salvage value of the materials at the end of the project life is used, but in many cases it is considered zero.

When W-beam guardrail is the improvement, the removal of snow should be used in the maintenance costs. It is estimated that snow removal costs are \$50 per foot.

The project life of a roadway design is a input value selected by the user. The discount rate is also a basic input value in the economic analysis.

Once the information is obtained, the total present worth and annualized costs are computed. An analysis program has been prepared to make a direct comparison between several proposed safety treatments.

III-14.05 Cost Estimate Selection Procedure

Collisions involving vehicles with roadside objects are a probable occurrence with any existing highway facility. The purpose of the cost effectiveness selection procedure is to provide a technique for comparing alternate solutions to problem locations. Present value of the total cost of each alternative is computed over a given period of time, taking into consideration initial cost, maintenance cost, and accident cost. Selection of the alternative with the least total cost would normally be made.

A program has been written to provide a cost effectiveness analysis for various traffic volume, foreslopes, roadway clearances, and costs. The cost effectiveness analysis is based on the requirements detailed in the "Roadside Design Guide," AASHTO latest issue called "RSAP."

The Road Safety Analysis Program (RSAP) Software was developed under National Cooperative Highway Research Program (NCHRP) Project 22-9 and represents one approach to using the *Roadside Design Guide*, as described in Appendix A of the this guide. The RSAP program is intended as a tool for economic analysis and should not supersede the guidelines presented in the *Roadside Design Guide* or sound engineering judgement.

III-14.06 Safety Enhancements

III-14.06.1 Fill Height

If fill height is greater than 10 feet, the foreslope steeper than 1:3, and the ADT greater than 750, foreslope flattening or guardrail protection should be considered. If the ADT is 750 or less, it is not considered cost effective to flatten the foreslopes or provide guardrail. It is the department's policy to flatten foreslopes even though the initial cost may be greater than guardrail. The decision to flatten the foreslope or to provide guardrail is an executive decision. Therefore, when the report is written, both the costs for guardrail and flattening slopes should be included.

III-14.06.2 Box Culverts, Pipe Culverts, and Cattle Passes

If the ADT is greater than 750, safety enhancement should be performed, including culvert extensions, grating, or guardrail using the most cost effective measure.

If the ADT is 750 or less, hazard markers should be installed in accordance with Standard Drawing D-754-82.

III-14.06.3 Side Road Approaches

If the side road approach foreslopes are steeper than 1:6, and the ADT is greater than 500, the slopes should be flattened to 1:8.

If the side road approach foreslopes are steeper than 1:6, and the ADT is 500 or less, the foreslopes should be flattened to 1:8 if it is cost effective. It has been determined that side road approach foreslopes 1:4 or steeper, and with ADT over 500, are cost effective to flatten to 1:8. Foreslopes between 1:6 and 1:4 should have cost effectiveness analyses done.

III-14.06.4 Clear Zones for 3R and 4R Projects

3R projects on rural two-lane roads should use a clear zone of 20 feet. 3R and 4R projects on expressways and freeways should use the clear zones given by Tables 1 and 2.